

gradually developing, and the general nutrition of the hand showed improvement. There was slight power of grasp and some power of flexion in the wrist, as well as slight power of adduction of the thumb and flexion of the fingers. Sensation was felt all over the thumb and index finger, in the second finger up to the first phalanx on the palmar aspect, also in the third finger, though less distinct. No sensation could be elicited over the distribution of the ulnar nerve.

On March 30th he began to have sharp shooting pains along the distribution of the ulnar nerve. On April 1st the flexors of the forearm began to react visibly to C.C.C., though the muscles of the thenar eminence did not, and there was no faradic reaction. On April 30th sensation was returning at the back of the ring finger, and the flexors now reacted to A.C.C. of 5 milliamperes.

On June 13th the nutrition of the hand was much improved, and there was a greater feeling of warmth in it. He could pick up small objects, and although the grasp was not powerful, it was much improved. The powers of flexion of the wrist and adduction of the thumb were considerably increased, but there was no sensation as yet over the ulnar distribution.

#### *Condition of the Patient Six Years after Operation.*

Being interested in the case, I made inquiries from time to time after he left Leeds, but I never saw him again until February, 1896, six years after the operation, when I asked him if he would let me demonstrate his case at the Leeds and West Riding Medico-Chirurgical Society, where my colleagues and other members of the society had the opportunity of seeing him. Dr. Mackay had applied galvanism to the muscles of the forearm and hand from time to time, from the time of his leaving Leeds until the middle of November of the same year, when all treatment was stopped. He did not resume work till March, 1891, not because he was unable to undertake light work, but, as the patient put it, "He wanted to give the arm a fair chance of complete recovery." Since March, 1891, he had not missed a single day's employment, and was able to do all his duties completely, from wheeling a well-laden barrow to using a scythe.

There was a firm round scar along the inside of the arm. The circumference of the right forearm was 11 in., left forearm 11½ in.; right wrist 7 in., left wrist 7½ in.

From these measurements it will be seen that the muscles had almost completely returned to their former volume, and in the hand all the muscles except the abductor of the thumb were as well developed as in the left; this was quite as well marked in the interossei as in the other muscles. The movements of the arm were completely restored and almost as perfect as in the left. Flexion of the fingers and the grasp had completely returned, and the only weak muscle was the abductor of the thumb, which had no perceptible power. Sensation was completely restored, as was easily demonstrated by touching the different portions of the arm and hand with a pin.

All the muscles of the arm and hand reacted to faradism except the abductor of the thumb.

It will thus be seen that, though the recovery had been tardy, it was complete in almost every respect, the only exception being that of the abductor pollicis, which for some unexplained reason did not recover its function. The case is very encouraging, since it clearly demonstrates the possibility of restoring continuity of nerves by grafting. Whether the spinal cord in this case simply served as a basis on which the nerve tissue was built up I am unable to say, but that it answered its purpose is clearly shown in the report of the case. Why restoration of function in the ulnar nerve should have taken longer than in the median I am unable to say, as the ends of the nerve were not separated more than ¾ in., whereas the ends of the median nerve were between 2 in. and 3 in. apart. Could it be that the spinal cord offered a better medium for establishing continuity? The patient was seen years subsequently, completely recovered in every respect.

Since operating on the above cases I have had considerable experience in the surgery of nerves, both with regard to suture of divided ends and in nerve grafting.

During the present war I have had experience both in the Dardanelles, in Egypt, and in the base hospitals at home in the treatment of nerve injuries, and my previous experience in civil practice has stood me in good stead in dealing with this class of cases.

Nerve grafting cannot, of course, be successfully performed in septic wounds, but where the paralysis remains after healing of the wound and it is known that it is not merely due to division of nerve or of some portion of the nerve trunk, as shown by the paralysis not improving under treatment, it seems to me desirable that too much time should not be allowed to pass before operative treatment is adopted in one or other of the ways I have described above, as it will lead in a large number of cases, if not in all, to complete restoration of function and thus to saving of otherwise useless limbs.

## NOTE ON THE INCIDENCE OF TETANUS AMONG WOUNDED SOLDIERS.

BY

SIR GEORGE-GENERAL SIR DAVID BRUCE, C.B., F.R.S.

The principal object of this paper is to draw attention to the effect of prophylactic injections of antitetanic serum in lowering the incidence of tetanus among wounded men. The chart represents the ratio of cases of tetanus to number of wounded men from the beginning of the war to the end of 1916. This diagram has been made up, not from all the cases of tetanus which have occurred, but only from those which have arisen in home hospitals among the wounded men sent to England from overseas. It does not include cases which have occurred in France or elsewhere.

It will be seen that the ratio in September, 1914, is 16 per 1,000; in October, 32 per 1,000; and that it falls in November to 2 per 1,000, about which figure it remains until the present date. To what cause must this remarkably sudden fall be attributed? No doubt there were various factors at work, but beyond all reasonable doubt the introduction of prophylactic injections of antitetanic serum was the preponderating cause. To understand this it may be well to give a short account of the movements of our army during these first months.

The bulk of the British Expeditionary Force crossed over to France on the night of August 12th and 13th, 1914. On the 18th and 19th the troops began to move northwards into Belgium.

The battle of Mons and the retreat took place between August 23rd and 30th. During the retreat many of the wounded fell into the enemy's hands, and on our own part it was impossible in many cases to carry out any thorough surgical treatment of the wounds owing to the hurried nature of the retreat.

The battle of the Marne was fought between September 7th and 10th.

On September 13th the British Expeditionary Force reached the valley of the Aisne, and remained here until the end of the month. This was the ground where probably many cases of tetanus were infected. The soil is rich and fertile, and has an evil reputation for tetanus. Here in ordinary times it is found necessary to inoculate the farm horses at intervals with tetanus antitoxin as an ordinary measure of precaution.

The troops left the valley of the Aisne about October 3rd, and took up positions at La Bassée and its neighbourhood, where fighting took place from October 11th to the end of the month.

The severe fighting round Ypres, in which a separate division of the army took part, began on October 20th and continued until November 11th, 1914.

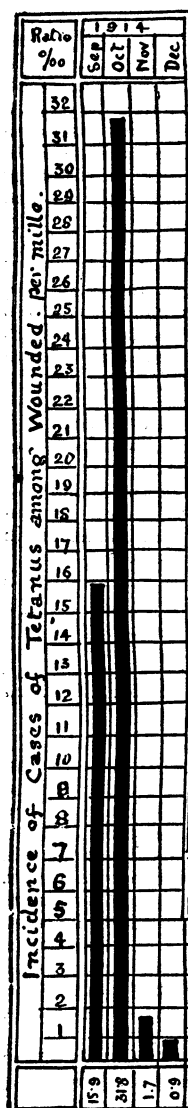
It is evident, then, that the 16 per 1,000 cases of tetanus among the wounded which occurred during September, must have been contracted at the battle of the Marne and in the valley of the Aisne. Further, that the abnormally high ratio of cases of tetanus which is found in October must have been to a great extent due to the tetanized soil of the Aisne valley.

There were therefore several factors at work in September and October, 1914, to raise the ratio—the heavy fighting with the consequent heavy toll of wounded, the highly infective character of the soil, the difficulty of collecting the wounded on account of their numbers and the movements of the troops, and finally the difficulty of giving the thorough surgical treatment to their wounds which is so essential in the fight against tetanus.

But there was another, and that the most important, factor which has not been taken into account—the prophylactic injection of tetanus antitoxin. This was not carried out during the first two months of the war. It would appear that in the beginning only a small quantity of antitoxin was taken out with the Expeditionary Force for purposes of treatment, and it was only when the number of cases of tetanus became alarming that steps were taken to ensure that every wounded man should receive a prophylactic dose.

Lord Kitchener telegraphed to the Director of Medical Services, Expeditionary Force, on September 8th as follows:

Earl Kitchener desires information as to whether antitetanus inoculations are being practised for wounded, and whether,



if not carried out in the field units, they are carried out in communication units. He wishes all to be impressed with this.

It was not, however, until about the middle of October that the practice of prophylactic inoculation was introduced on anything like a complete scale, and it was at this time that the remarkable fall in the incidence of tetanus took place. A letter received from Sir William Leishman at head quarters in France corroborates this. He says that it was not until the battle of the Aisne that any one knew what a lot of tetanic infection was going to occur, and the demands for serum increased. Early in October many wounded had not been inoculated, but about the middle of the month the supply sent over became equal to the demand and its use became practically universal. He concludes by saying that he feels sure that the drop in the incidence of tetanus in November, 1914, was due to the use of the prophylactic dose, and does not think any large complicating factor comes in.

This is borne out by the amount of serum sent out to France in the first five months—August, 1914, 600 doses; September, 12,000; October, 44,000; November, 112,000; December, 120,000 doses.

The benefit of prophylactic injection

On account of certain circumstances in a batch of 200 wounded, 100 only received a prophylactic injection. This series furnished a single case of tetanus, and in this case tetanus began on the day of the injection, so that one could not say that the injection had a chance to exercise any prophylactic action. One may therefore say the incidence was zero.

In the second batch of 100, which presented wounds comparable to the previous batch but received no injection, there were 18 cases of tetanus—that is to say, 18 per cent.

Kummell also, in the *Berlin. Klin. Woch.*, comes to the same conclusions. He says that the picture of tetanus produced by the severity and the number of the cases shortly after the outbreak of the war has disappeared. He considers that early prophylactic injection of the wounded is an almost certain preventive of tetanus, and recommends that the injection should be repeated about seven days after the first injection if an operation, however slight, has to be undertaken.

The Committee of the War Office for the study of tetanus goes further and recommends that a second subcutaneous injection of 500 units should be given in all cases of septic wounds, and in order to anticipate the total disappearance of the antitoxin from the body the second injection should follow the first at an interval of seven days; also in cases of long-continued septic wounds, particularly those caused by shell or bomb, third and fourth injections at seven-day intervals are recommended. The Committee also states definitely that the danger of anaphylactic shock is negligible when prophylactic doses of 500 U.S.A. units contained in 3 c.cm. of horse serum are given subcutaneously, whatever the interval after the preceding injection.

As many medical officers doing duty in home military hospitals appear to be doubtful as to the good to be gained by these second and further prophylactic doses of tetanus antitoxin, this paper has been written in order to try to strengthen their faith. There can surely be no doubt in anybody's mind

that an ounce of prophylactic serum is worth pounds of the same serum used therapeutically. There is always a chance that a wounded man in the confusion and stress of a crowded clearing station may escape his first prophylactic injection. So much the more reason, then, that he should get one as soon as he arrives in a home hospital. To inject two or three cubic centimetres of serum under the skin causes no great trouble, and cannot be dangerous. As Kummell says, the picture of tetanus as seen at the beginning of the war has quite changed. The incubation period has become longer, the number of cases of localized tetanus has greatly increased, and the mortality has been lowered.

#### CONCLUSION.

The incidence of tetanus among wounded men falls sharply on the introduction of prophylactic injections of antitoxin, and it is much to be desired that the primary injection be followed up by secondary and further prophylactic doses as long as the wound remains suspicious.

### NOTES ON THREE CASES OF TETANUS.

BY

CAPTAIN R. I. DOUGLAS, AND CAPTAIN C. H. CORBETT,  
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In view of the uncertainty that still seems to exist as to the appropriate treatment of tetanus with antitetanic serum, and the desirability of putting all cases of recovery on record, it is thought that the following three cases will prove interesting. They are examples of cases in which a vigorous policy in serum treatment has apparently helped to ultimate recovery.

#### CASE I.

Pte. I. Frostbite in both feet, contracted on November 25th, 1915, and following three days. On December 15th the toes on both feet were gangrenous. Antitetanic serum 1,500 units was given subcutaneously as a prophylactic dose. On the following day he had a sore throat and the temperature was 100° F. On December 18th he had slight stiffness in the jaw and the back of the neck. The knee-jerks were very brisk, and he complained of twitchings in both legs. Spinal puncture was made,

and clear fluid drawn off; it was subsequently found to be bacteriologically sterile. Antitetanic serum 8,000 units was given intrathecally, and the patient was removed to a secluded darkened ward.

On December 19th the symptoms were increased. The temperature was 102° F., the pulse 96, and the respirations 30. The toes were painted with iodine and spirit. Antitetanic serum 5,000 units was given subcutaneously, and 6,000 units intravenously (arm). On December 20th there were increased twitchings in the legs on attempted movement and risus sardonius. Antitetanic serum 4,000 units was given intrathecally under chloroform.

On December 21st he was not so well; four or five spasms were noticed during the day and much reactionary stiffness following them; there was some difficulty in swallowing. Antitetanic serum 2,000 units was given subcutaneously and 8,000 units intramuscularly into the thighs below the level of a tight bandage by which the circulation was partially obstructed for ten minutes; 6,000 units were given intravenously in the right leg below the bandage, and 6,000 intrathecally (under chloroform). He had a bad night, and on December 22nd the musculature generally was stiff, swallowing was difficult, he would not take food, and was obviously frightened to attempt movement. Antitetanic serum 10,000 units was given intramuscularly into the calves (5,000 into each calf below the level of a bandage), and 10,000 units intravenously (5,000 into each leg